Review Packet for M&V Summit Participants

M&V Plan Outline Working Group

M&V Plan Outline working group

Date of status report: October 24th, 2003

Date formed: June 2003

Objectives of the working group:

- Develop a generic M&V plan outline that define minimum requirements for use across the federal sector

Expected Date of Completion: November 2003

Final Deliverable(s):

- Define major (basic) elements of a federal M&V plan/outline (September 1, 2003; August 1st 2003 for interim deliverable)
- Add guidance to approved federal M&V plan outline (November 2003)

Additional notes for the working group:

- Review FEMP Template, AF Template, IPMVP, and any other documents that provide guidance on the development of a M&V plan.
- Come up with a generic "M&V Plan" definition that is acceptable to all the different programs
    - Compare the M&V requirements of different programs and then filter the core elements common to all the programs, including Annual Report Outline developed by the M&V Annual Reporting Working Group.
- Develop an optimal M&V plan outline without constraint of existing contracts

Discussion Documents for the working group:

- M&V Plan Template Draft - 10-24-03
- Post Installation Report Outline - 10-24-03
- M&V Plan Template Draft - 10-01-03
- M&V Plan Template Draft - 9-10-03
- M&V Plan Template Draft - 8-28-03
- M&V Plan Template Draft - 8-14-03
- M&V Plan Template Draft - 7-31-03
- FEMP M&V Plan Template Draft - 4-23-03
- AF Generic M&V Outline Draft - 07-23-03
- Comparison of FEMP and AF M&V Plan Template

Current Status:

- View running notes from past conf. calls

Committee Chairperson: Lia Webster

Members of the working group

No.	First Name	Last Name	Company Name	Phone No.	Email
1	Tom	Adams	HQ Air Force, Civil Engineering Support Agency		Tom.Adams@tyndall.af.mil
2	Ron	Araujo	Select Energy Services, Inc.	860 665-3211 x211	araujrj@selectenergy.com
3	Michael	Cross	HQ Air Force, Civil Engineering Support Agency	850-283-6481	Michael.Cross@tyndall.af.mil
4	Charlie	Culp	Energy Systems Laboratory	979-458-2654	cculp@tamu.edu
5	Doug	Dahle	NREL	303-384-7513	douglas_dahle@nrel.gov
6	Steve	Dunnivant	NREL Sub-contractor (EMP2)	509-783-5176	steved@emp2.com
7	Jimmy	Haywood	US Army Corps of Engrs, Engr & Support Center	256-895-1719 x1140	jimmy.c.haywood@hnd01.usace.army.mil
8	Max	Hogan	Naval Facility Engineering Service Center	805-982-1557	hoganmm@nfesc.navy.mil
9	Mohammad	Huq	Ameresco	704-373-6906	mhuq@ameresco.com
10	Scott	Judson	NORESCO	617-542-8567 x126	sjudson@noresco.com
11	Satish	Kumar	LBNL	202-646-7953	SKumar@lbl.gov
12	Darryl	Matsui	Naval Facility Engineering Service Center	619-532-3985	matsuids@nfesc.navy.mil
13	Bonnie	Piest	Johnson Controls	425-398-6960	Bonnie.L.Piest@jci.com
14	David	Purcell	HQ, US Army	703-428-7613	David.Purcell@hqda.army.mil
15	Balaji	Santhanakrishnan	Brooks Energy and Sustainability Lab	210-534-7227 x45	balajisk@tamu.edu
16	Dale	Sartor	LBNL	510-486-5988	DASartor@lbl.gov
17	Mark	Stetz	Nexant, Inc.	970-385-4932	mstetz@nexant.com
18	Eric	Vaughan	Honeywell International Inc.	205-612-6530	eric.vaughan@honeywell.com
19	David	Ward	Energy Engineering & Design, Inc.	(508) 405-1946	david.ward@rcn.com
20	Lia	Webster	Nexant, Inc.	303-402-2493	lwebster@nexant.com
21	David	Williams	HQ, US Army	703-428-	David.Williams2@hqda.army.mil

				6175	

Draft M&V Plan Outline

1. Executive Summary / M&V Overview

1.1 Annual Savings Overview

ECM	Electric Energy Savings (kWh)	Electric Demand Savings (kW)	Natural Gas Savings (therms)	Fuel Oil (gallons)	Water (gallons)	Etc…	O&M Cost Savings	Annual Energy Cost Savings ($)	Total Annual Cost Savings
Total Savings:									
Total Site Usage*:									
% Saved:									

*If available

Include all applicable fuels / commodities for project, such as: electric energy, electric demand, natural gas, fuel oil, coal, water, etc.

1.2 M&V Approach Summary

ECM	ECM Description	M&V Option Used*	Summary of M&V Approach

*Reference M&V guideline used, for example: *M&V Guidelines: Measurement & Verification for Federal Energy Projects, Version 2.2*; or *International Performance Measurement & Verification Protocol (IPMVP) Volume I* March 2002

2. Whole Project Data / Global Assumptions

2.1 Risk & Responsibility

2.1.1 Summarize allocation of responsibility for key items related to M&V

- Reference location of Risk & Responsibility Matrix[1] (if required)

[1] ESPC Contract Risk & Responsibility Matrix is available in the DOE IDIQ, FEMP M&V Guidelines V 2.2, and through http://ateam.lbl.gov/mv

2.1.2 Discuss agreed upon requirements for uncertainty analysis

2.2 Utility Rate Data

2.2.1 Baseline Commodity rates

2.2.2 Performance Period Commodity Rate Adjustment Factors, if used

2.3 Schedule & Reporting for M&V Activities

2.3.1 Define requirements for witnessing of measurements

- Baseline
- Post-installation verification activities
- Performance Period

2.3.2 Define schedule of M&V reporting activities

Item	**Expected Time of Submission**	**Owner's review & acceptance period**
Final Commissioning Plan		
Post-installation M&V Report		
Commissioning Report		
Annual Report		

2.3.3 Define content and format of reports

- Post-installation M&V report

  → Use of FEMP Post-Installation M&V Report Outline[2] is recommended

- Commissioning report

  → *TBD by Cx working group*

- Periodic M&V reports

  → Use of FEMP Annual Report Outline[3] is recommended.

2.4 O&M Reporting Requirements

2.4.1 Government Reporting Requirements

- Summarize key verification activities and reporting responsibilities of government on operations and maintenance items from details in ECM specific M&V Plans.

[2] *Draft Post-Installation Report Outline* is available through http://ateam.lbl.gov/mv.

[3] *Annual Report Outlinee* is available through http://ateam.lbl.gov/mv.

2.5 Dispute Resolution

3. ECM Specific M&V Plan (develop for each ECM)

3.1 Overview of ECM and M&V plan for ECM

3.1.1 Scope of work, location, and how cost savings are generated

3.1.2 M&V guideline and option used[4]

3.1.3 Intent of M&V plan – what is being verified

3.2 Energy Baseline Development

Describe in general terms how the baseline for this ECM is defined.

3.2.1 Variables Affecting Baseline Energy Use

- Variables such as weather, operating hours, set point changes, etc.
- Describe how each variable will be quantified, i.e. measurements, monitoring, assumptions, manufacturer data, maintenance logs, engineering resources, etc.
- Discuss variables' impact on savings uncertainty

3.2.2 Define key system performance factors characterizing the baseline conditions

- Such as comfort conditions, lighting intensities, temperature set points, etc.

3.2.3 Requirements for government witnessing of measurements if different than whole project data requirements included in Section 2.3.

3.2.4 Baseline Data Collected

- Parameters Monitored
- Details of equipment monitored, i.e. location, type, model, quantity, etc.
- Desired uncertainty level
- Sampling plan, including details of usage groups and sample sizes
- Duration, frequency, interval, and seasonal or other requirements of measurements
- Personnel, dates, and times of measurements
- Proof of government witnessing of measurements (if required)
- Monitoring equipment used
- Installation requirements for monitoring equipments (test plug for temperature sensors, straight pipe for flow measurement etc.)
- Certification of calibration / calibration procedures followed
- Expected accuracy of measurements/monitoring equipment
- Quality control procedures used
- Form of data (.xls, .cvs, etc.)

[4] Guidelines include *M&V Guidelines: Measurement & Verification for Federal Energy Projects, Version 2.2*; International Performance Measurement & Verification Protocol (IPMVP) Volume I March 2002 www.ipmvp.org. Options include A, B, C & D.

- Results of measurements (attach appendix if necessary)
- Completed data collection forms, if used

3.2.5 Data Analysis Performed

- Analysis using results of measurements
- Weather normalized regressions
- Weather data used and source of data

3.3 Energy Savings Calculations

3.3.1 Analysis methodology used

3.3.2 Detail all assumptions and sources of data

3.3.3 Equations used, savings calculation details

- Detail any adjustments that may be required

3.4 Operational & Maintenance Cost Savings

3.4.1 O&M Savings Justification

- Describe how savings are generated
- Detail cost savings calculations

3.4.2 Performance Period O&M Cost Adjustment factors, if used

3.5 Total Annual Savings For ECM

	Electric Energy (kWh)	Electric Demand (kW)	Natural Gas (therms) …	Fuel Oil (gallons)	Water (gallons)	O&M Cost Savings	Annual Energy Cost Savings ($)	Total Annual Cost Savings
Baseline Use								
Post-Install Use								
Savings								

Include all applicable fuels / commodities for project, such as: electric energy, electric demand, natural gas, fuel oil, coal, water, etc.

3.6 Post-Installation Verification Activities

Describe the intent of post-installation verification activities, including what will be verified.

3.6.1 Variables Affecting Post-installation Energy Use

- Variables such as weather, operating hours, set point changes, etc.
- Describe how each variable will be quantified, i.e. measurements, monitoring, assumptions, manufacturer data, maintenance logs, engineering resources, etc.
- Discuss variables' impact on savings uncertainty

3.6.2 Define key system performance factors characterizing the post-installation conditions

- Such as comfort conditions, lighting intensities, temperature set points, etc.

3.6.3 Key parameters to be verified during commissioning and to be included in Commissioning Plan

3.6.4 Requirements for government witnessing of measurements if different than whole project data requirements included in Section 2.3.

3.6.5 Post-Installation Data To Be Collected

- Parameters To Be Monitored
- Details of equipment to be monitored (location, type, model, quantity, etc.)
- Desired uncertainty level
- Sampling plan, including details of usage groups and sample sizes
- Duration, frequency, interval, and seasonal or other requirements of measurements
- Monitoring equipment to be used
- Installation requirements for monitoring equipment
- Calibration requirements / procedures,
- Expected accuracy of measurements/monitoring equipment
- Quality control procedures to be used
- Form of data to be collected (.xls, .cvs, etc.)
- Sample data collection forms (optional)

3.6.6 Data analysis to be performed and minimum acceptance requirements

3.7 Periodic / Interval Verification Activities

3.7.1 Variables Affecting Performance Period Energy Use

- Variables such as weather, operating hours, set point changes, etc.
- Describe how each variable will be quantified, i.e. measurements, monitoring, assumptions, manufacturer data, maintenance logs, engineering resources, etc.
- Discuss variables' impact on savings uncertainty

3.7.2 Define key system performance factors characterizing the performance period conditions

- Such as comfort conditions, lighting intensities, temperature set points, etc.

3.7.3 Intent of periodic verification activities – what will be verified

3.7.4 Schedule of periodic verification activities and inspections

3.7.5 Requirements for government witnessing of measurements if different than whole project data requirements included in Section 2.3.

3.7.6 Data to be collected

- Parameters To Be Monitored

- Details of equipment to be monitored (location, type, model, quantity, etc.)
- Desired uncertainty level
- Sampling plan, including details of usage groups and sample sizes
- Duration, frequency, interval, and seasonal or other requirements of measurements
- Monitoring equipment to be used
- Installation requirements for monitoring equipment
- Calibration requirements / procedures,
- Expected accuracy of measurements/monitoring equipment
- Quality control procedures to be used
- Form of data to be collected (.xls, .cvs, etc.)
- Sample data collection forms (optional)

3.7.7 Data analysis to be performed and minimum acceptance requirements

3.7.8 Operations and Maintenance (O&M) Reporting Requirements

- Detail verification activities and reporting responsibilities of government and ESCO on operations and maintenance items.
- State organization(s) responsible for equipment operations. If appropriate, detail how responsibilities are shared or reference where this information is located.
- State organization(s) responsible for performing maintenance. If appropriate, detail how responsibilities are shared or reference where this information is located.

Draft Post-Installation Report Outline

Contract # / Delivery Order # / Task #: include as appropriate

Performance Period Dates Covered: _____ to_____

1. Executive Summary

1.1 Project Background

1.2 Brief project and ECM descriptions – what was done and how savings are generated. Note any changes in project scope.

1.3 Projected energy and cost savings for the first year of the performance period:

1.3.1 Table showing the projected savings for the total project broken out by operations & maintenance (O&M) costs, energy units, energy cost, and other savings for this period. Compare to guaranteed cost savings for total project.

1.3.2 Table showing the projected savings by ECM broken out by O&M savings, energy units, energy cost, and other savings values (as applicable) for this period

1.3.3 Approximate % saved by energy source type for site (optional)

1.4 Summary of any energy and/or cost savings adjustments required. Describe the impact in changes between the Final Proposal and as-built conditions.

1.5 Summary of construction period savings

2. Details for each ECM

2.1 Overview of ECM – where implemented and how cost savings are generated

2.2 Installation Verification

2.2.1 Detail any changes between Final Proposal and as-built conditions

2.2.2 Describe construction period savings (if applicable). Include date ECM was in effect, and reference acceptance documentation.

2.2.3 Detail savings calculations for construction period savings

2.3 Detail results of commissioning activities, as specified in Commissioning Plan. Reference report if Commissioning Report is a separate submittal.

2.4 Overview of M&V plan for ECM

2.4.1 Intent of M&V plan – what is being verified

2.4.2 Description of analysis and equations used for savings calculations (include appendix and electronic format as needed and/or refer to specific section of contract)

2.4.3 Stipulated values from contract (include details and/or refer to specific section of contract)

2.5 Post-installation measurements, monitoring and inspections conducted in accordance with M&V plan (include all that apply for each one):

2.5.1 Measurement equipment used

2.5.2 Equipment calibration documentation

2.5.3 Dates/times of data collection or inspections, names of personnel, and documentation of government witnessing

2.5.4 Details to confirm adherence to sampling plan

2.5.5 Include all post-installation measured values. Include periods of monitoring and durations and frequency of measurements. (Use appendix and electronic format as necessary). Include description of data format (headings, units, etc.).

2.5.6 Energy & cost savings impact from changes between Final Proposal and as-built conditions

2.5.7 Describe how performance criteria have been met.

2.5.8 Detail any performance deficiencies that need to be addressed by ESCO or Government

2.5.9 Note impact of performance deficiencies or enhancements on generation of savings

2.6 Details of O&M Savings (if applicable)

2.6.1 Describe source of savings

2.7 Details of other savings (if applicable)

2.7.1 Describe source of savings

2.7.2 Describe verification activities conducted

2.8 Detail commodity (e.g. energy, water, etc.) rate(s) used in calculations

2.8.1 Actual commodity rate(s) at site for same period (optional)

2.9 Technical details of all calculations made. (Use appendix and electronic format as necessary.) Include description of data format (headings, units, etc.).

2.9.1 Analysis Methodology – describe any data manipulation or analysis that was conducted prior to applying savings calculations

2.9.2 Details of any baseline or savings adjustments made

2.9.3 Projected savings for this energy conservation measure (ECM)

2.10 Other comments

Project Documentation Working Group

Project Documentation working group

Date of status report: October 21st, 2003

Date formed: May 29th, 2003

Objectives of the working group:

- Develop documentation framework to ensure project/contract continuity over the Delivery Order/Task Order life.

Expected Date of Completion: October 15th , 2003

Final Deliverable(s):

- Provide recommendation to the Board on the documentation requirements for all Federal ESPC (interim deliverable)
  - Technical
  - Contractual
- Provide recommendation to the Board on file format and structure (interim deliverable)
- Following Board approval, establish file format structure – combine technical and contractual requirements
- Following Board approval, establish ownership, management, and access protocols

Discussion Documents for the working group:

- M&V Summit Draft Presentation to brief the Summit audience on the progres made so far by the Project Documentation Working Group (October 20th, 2003)
- Proposed Project Documentation Structure (September 22nd, 2003)
- Project-Documentation-Structure - Comments from Technical Folks (September 22nd, 2003)
- Project-Documentation-Structure - Comments from Contractual Folks (September 22nd, 2003)
- Project-Documentation-Structure - Second Draft (August 4th, 2003)
- Project-Documentation-Structure - Initial Draft
- Project Documentation - Brainstorming Ideas From Summit
- ESPC Project Documentation Matrix

Current Status:

- View running notes from past conf. calls

Committee Chairpersons: Satish Kumar

Members of the working group

No.	First Name	Last Name	Company Name	Phone No.	Email
1	Robert	Baugh	Oak Ridge National Laboratory	865-574-7639	baughrn@ornl.gov
				303-384-	

2	Doug	Dahle	NREL	7513	douglas_dahle@nrel.gov
3	Jeff	Dominick	NREL	303-384-7307	jeffrey_dominick@nrel.gov
4	Max	Hogan	Naval Facility Engineering Service Center	805-982-1557	hoganmm@nfesc.navy.mil
5	Craig	Hustwit	NETL	412-386-4532	hustwit@netl.doe.gov
6	Satish	Kumar	LBNL	202-646-7953	SKumar@lbl.gov
7	Jose	Maniwang	US Navy	202-685-9255	maniwangjv@navfac.navy.mil
8	Darryl	Matsui	Naval Facility Engineering Service Center	619-532-3985	matsuids@nfesc.navy.mil
9	Teresa	Nealon	NREL	303-384-7486	teresa_nealon@nrel.gov
10	David	Purcell	HQ, US Army	703-428-7613	David.Purcell@hqda.army.mil
11	Linda	Sisk	HQ Air Force, Civil Engineering Support Agency	850-283-6220	Linda.Sisk@tyndall.af.mil
12	Tatiana	Strajnic	DOE-FEMP	202-5869230	tatiana.strajnic@ee.doe.gov
13	Lia	Webster	Nexant, Inc.	303-402-2493	lwebster@nexant.com
14	David	Williams	HQ, US Army	703-428-6175	David.Williams2@hqda.army.mil
15	Chris	Wyatt	Concurrent Technologies Corp., at the NETL	304-285-0959	cwyatt@ct.netl.doe.gov

Project Documentation - Hierarchical outline for the file structure (site map)						
Suggested documentation – core documents through project life						
1. Pre-Award documents						
	a. Site Data – Government generated					
		i. Site Data Package				
		ii. Audit Studies/Surveys				
	b. Initial Proposal (IP)/Phase I approval notification					
	c. IP/Phase I document					
	d. FEMP Services Agreements					
		i) SOW				
		ii) IAG/Work Order				
	e. Notice of intent (NOI) to award					
	f. Congressional notification letter, if applicable (project > $10 million)					
	g. DO RFP/SOW					
		i. Terms and Conditions				
		ii. Attachments				
	h. Price reasonableness determination					
	i. Final ESCO Proposal/Detailed Energy Survey					
		i. ECM and Savings Descriptions				
		ii. Baseline and M&V				
			a. Acceptance (what is required for acceptance)			
			b. Annual Verification (How will this be performed)			
				i. Year 1 Requirements		
				ii. Year 1+N Requirements		
			c. Energy Performance Tests Schedules			
		iii. Management Plan				
			a. Responsibility Matrix			
2. Award documents						
	a. Cover page of the Delivery Order (DO)/Task Order (TO) Award Form DD 1155___ SF 33 ___ Other_____					
	b. DO/TO Terms and Conditions					
	c. Price Schedules (e.g. DO Schedules)					
	d. Negotiated Final ESCO proposals					
	e. Contract modifications					
	f. Contract Documents and Correspondence					
		i. Kickoff Meeting Minutes				
		ii. Project Development Schedules				
		iii. Submittal Review				
		iv. Proposal Comments				

3.	**Project Implementation and Final Submittals**					
	a. 100% Design/Red-lined Drawings					
	b. Detailed Installation Schedule					
	c. Installation Plan					
	d. Commissioning Plan					
	e. Acceptance Test Plan					
	f. Project Acceptance Checklist/Report					
	g. As built drawings					
	h. Commissioning Report					
	i. Post-Installation M&V Report					
	j. O&M Matrix					
	k. Manuals (e.g., O&M)					
	l. Training documents					
4.	**Performance Period**					
	a. Annual M&V reports					
		i. Year 1 thru N- Savings Calculations/Reconciliation				
		ii. Baseline Adjustments				
	b. R&R documents					
	c. O&M documents					
	d. Payment records					
5.	**Project Information**					
	a. Agency					
	b. Location					
	c. Building Type					
	d. Project Title/Description					
	e. Status (e.g., costs incurred and milestones completed)					
	f. Contacts – FEMP team, agency/site, contractor					
	g. Case Studies					
	h. PowerPoint Presentations					
	i. Press Releases					
	j. Photos					

Commissioning Working Group

Commissioning working group

Date of status report: October 27th, 2003

Date formed: October 24th, 2001

Objectives of the working group:

- Mainstream Use of Commissioning into the DOE SuperESPC Projects
- Modify IDIQ Contract to address Commissioning Requirements

Expected Date of Completion: 4th Quarter 2003

Final Deliverable(s):

- Commissioning content recommendations to be incorporated into revision of IDIQ contracts

Current Status:

- Commissioning DO Guidance currently in use on selected projects to identify potential project impacts and improvement
- Adopted Commissioning Provisions for DO-RFP use
- Using Commissioning Provisions in selected projects
- View running notes from past conf. calls

Accomplishments to Date:

- Update Project Management Guidance Document for Commissioning – (Spring '03)
- Training PF's/ESCO's – (Spring '03)
- Updated PMP - Agency Witness (Spring '03)
- Issued Cx – DO-RFP Updates (Fall '02)
- Updated PMP – Cx (Fall '02)

Planned Action:

- Review Draft ESPC Cx Guidelines – 1st Qtr FY04
- Select Cx Pilot Project - 1st Qtr FY04
- Standardize Cx Report requirements – 2nd Quarter FY04.
- Training of PF's/ESCO's - 3rd Quarter 2004
- Provide IDIQ contract input - 2nd Quarter 2004

Committee Chairperson: Steve Dunnivant, NREL Sub/EMP2

Members of the working group

No.	First Name	Last Name	Company Name	Phone No.	Email

1	Sylvia	Berry-Lewis	Honeywell International Inc.	301-847-7396	Sylvia.Berry-Lewis@honeywell.com
2	Cynthia	Brockey	APS Energy Services	(602) 744-5035	Cynthia_Brockey@apses.com
3	Michael	Cross	HQ Air Force, Civil Engineering Support Agency	850-283-6481	Michael.Cross@tyndall.af.mil
4	Jerry	Culbert	Select Energy Services, Inc.	508-653-0456 x1289	jculbert@selectenergysi.com
5	Charlie	Culp	Energy Systems Laboratory	979-458-2654	cculp@tamu.edu
6	Doug	Dahle	NREL	303-384-7513	douglas_dahle@nrel.gov
7	Charles	Dorgan	Fransworth Group	608-827-6880	cedorgan@wisc.edu
8	Chad	Dorgan	Fransworth Group	909-340-1686	cbdorgan@f-w.com
9	Clayton	Dumcum	Chevron Energy Solutions, Federal Business Unit	651-905-5751	cdumcum@chevrontexaco.com
10	Steve	Dunnivant	NREL Sub-contractor (EMP2)	509-783-5176	steved@emp2.com
11	John	Evarts	NORESCO	802-349-9072	jevarts@noresco.com
12	Kristin	Heinemeier	Energy Systems Laboratory	210-534-7227	kristin-h@tamu.edu
13	Max	Hogan	Naval Facility Engineering Service Center	805-982-1557	hoganmm@nfesc.navy.mil
14	Marc	Jeanson	Johnson Controls	858-614-8554	marc.jeanson@jci.com
15	John	Johnson	ConEd Solutions		johnsonjohn@conedsolutions.com
16	Roger	Johnson	Fransworth Group	608-827-6880	rjohnson@f-w.com
17	Scott	Judson	NORESCO	617-542-8567 x126	sjudson@noresco.com
18	Venkat	Kumar	Johnson Controls	414-524-4700	venkat.kumar@jci.com
19	William	Lintner	Department of Energy	202-586-3120	William.Lintner@ee.doe.gov
20	Mike	MacDonald	ORNL	865-574-5187	macdonaldjm@ornl.gov
21	Darryl	Matsui	Naval Facility Engineering Service Center	619-532-3985	matsuids@nfesc.navy.mil
22	Jay	McCarroll	APS Energy Services	(602) 744-5393	Jay_McCarroll@apses.com
23	Robert	McMillin	Siemens	713-462-9071	robert.mcmillin@siemens.com
24	Wilson	Reynolds	EME, Inc. (NREL Sub-contractor)	719-634-6616	dosbobos@aol.com

25	Balaji	Santhanakrishnan	Brooks Energy and Sustainability Lab	210-534-7227 x45	balajisk@tamu.edu
26	Dale	Sartor	LBNL	510-486-5988	DASartor@lbl.gov
27	Margaret	Selig	Herlihy Corporation	(704) 522-3821	MSelig@HerlihyCorp.com
28	Gary	Snead	Trigen Energy Services	410-649-2201	gsnead@trigen.com
29	Mark	Stetz	Nexant, Inc.	970-385-4932	mstetz@nexant.com
30	Dave	Underwood	USA CERL	217-373-6780	D-Underwood@cecer.army.mil
31	Mark	Vilchuck	Chevron Energy Solutions, Federal Business Unit	651-261-9190	mvilchuck@chevrontexaco.com
32	Phil	Voss	NREL	303-384-7544	philip_voss@nrel.gov
33	Lia	Webster	Nexant, Inc.	303-402-2493	lwebster@nexant.com

CX Pilot Project - Application Draft

This form has been developed to assist the FEMP Cx Working Group in selection of a Project Pilot – please submit the form to Doug Dale (Doug_Dahle@nrel.gov) or Steve Dunnivant (steved@emp2.com) for Cx Working Group consideration.

Project Name: _____
Agency: _____
Agency Contact: _____
Phone: _____ e-mail: _____
ESCO: _____

ESCO Contact: _____
Phone: _____ e-mail: _____
Project Facilitator:_____
Phone: _____ e-mail: _____
Other Contacts: _____
Phone: _____ e-mail: _____

Selection Criteria

- ☐ DOE SuperESPC Delivery Order: Identify DOE Region _____
- ☐ Timing – Early in Project: Provide Brief Summary of current Project Schedule _____
- ☐ Agency – Commitment: Describe customer understanding of Cx value and commitment to Cx process _____
- ☐ Project Economics can accommodate CX: Provide summary project financials including investment, annual savings and term (or attach DO schedule). _____ _____
- ☐ Project ECMs – Comprehensive: List ECM types or attach DO-4 _____ _____
- ☐ Project at NOI phase: Provide expected date of NOI. _____
- ☐ Agency – Staff Capability/Resources: Describe Agency Project Mgt./Engineering staff capacity. _____
- ☐ Previous ESPC Experience: Describe Agency ESPC Experience at this or other related sites. _____

Retro-Commissioning Working Group

Retro-Commissioning working group

Date of status report: October 27th, 2003

Date formed: December 7th, 2001

Objectives of the working group:

- Filter information and provide guidance on retro-comissioning (retro-Cx) to rest of the FEMP team to help facilitate implementation of retro-comissioning projects
- Identify difficulties as well as solutions for the related issues facing Federal ESPC program
- Develop general strategy to M&V retro-Cx projects in the federal sector.

Expected Date of Completion: None - ongoing effort

Final Deliverable(s):

- Marketing documents on retro-Cx for Federal ESPC program.
- Develop example scope of work for retro Cx services.

Discussion Documents for the Working Group:

- **Marketing Outline**
  - **RetroCx Outline (10/27/03)**
  - RetroCx Outline (9/16/03)
  - RetroCx Outline (7/15/03)
  - RetroCx Outline (8/08/02)
- **Scope of Work for Including Retro-Cx in Federal ESPC projects**
  - **Scope of Work for retro (10/27/03)**
  - Scope of Work for retro (9/16/03)
  - Scope of Work for retro (8/22/03)

Current Status:

- View running notes from past conf. calls

Committee Chairperson: Lia Webster

Members of the working group

No.	First Name	Last Name	Company Name	Phone No.	Email
1	Mustafa	Abbas	Sempra Solutions		MAbbas@semprasolutions.com
2	Robert	Baugh	Oak Ridge National Laboratory	865-574-7639	baughrn@ornl.gov
3	David	Braslau	Alliant Energy Integrated	978-441-	dbraslau@alliantenergyisco.com

			Services	0090 x295	
4	Bill	Chvala	PNNL	509-372-4558	william.chvala@pnl.gov
5	Jerry	Culbert	Select Energy Services, Inc.	508-653-0456 x1289	jculbert@selectenergysi.com
6	Charlie	Culp	Energy Systems Laboratory	979-458-2654	cculp@tamu.edu
7	Doug	Dahle	NREL	303-384-7513	douglas_dahle@nrel.gov
8	Steve	Dunnivant	NREL Sub-contractor (EMP2)	509-783-5176	steved@emp2.com
9	K. Quinn	Hart	HQ Air Force, Civil Engineering Support Agency	850-283-6361	Quinn.Hart@tyndall.af.mil
10	Craig	Hustwit	NETL	412-386-4532	hustwit@netl.doe.gov
11	John	Johnson	ConEd Solutions		johnsonjohn@conedsolutions.com
12	Scott	Judson	NORESCO	617-542-8567 x126	sjudson@noresco.com
13	Tim	Kehrli	NREL Sub-contractor (TLK Consulting)	425-822-6317	tkehrli@nwlink.com
14	Michael	Parker	Johnson Controls	505-248-1930	michael.s.parker@jci.com
15	Balaji	Santhanakrishnan	Brooks Energy and Sustainability Lab	210-534-7227 x45	balajisk@tamu.edu
16	Dale	Sartor	LBNL	510-486-5988	DASartor@lbl.gov
17	Margaret	Selig	Herlihy Corporation	(704) 522-3821	MSelig@HerlihyCorp.com
18	Lia	Webster	Nexant, Inc.	303-402-2493	lwebster@nexant.com

Including Retro-Commissioning In Federal Energy Saving Performance Contracts

Retro-commissioning generally reduces operating and maintenance costs, improves building occupant comfort, and meets changing operational needs. When retro-commissioning (retro-Cx) is partnered with an energy saving performance contract such as Super ESPC, which focuses on equipment replacement and other capital improvements, a facility can greatly improve overall operations and dramatically reduce operating costs.

Including retro-commissioning in Federal performance contracting projects can provide substantial benefits. Retro-Cx can shorten the contract length of an ESPC by maximizing the project's cost savings. Retro-Cx activities commonly discover low-cost energy saving measures that may have otherwise been overlooked. Generally, retro-commissioning requires data logging of equipment operations, which provides additional documentation of the pre-retrofit baseline conditions and contributes to more robust M&V.

A project implemented at a large Federal facility in Atlanta is one retro-commissioning success story. A retro-commissioning project implemented for a total cost of about $120,000 will generate annual cost savings of approximately $250,000. Had this measure been included in the average Federal ESPC project ($3.1 million initial investment, 14 year contract) it would have effectively shortened the project's overall simple payback by more than 5 years.

When including retro-commissioning with other facility retrofits a graded approach should be used to determine the appropriate scope of retro-commissioning activities. An example scope of work for retro-commissioning has been developed for use in Federal ESPC projects. This *Example Retro-Commissioning Scope of Work* provides a comprehensive scope of work that can be modified for use in individual projects, and is available through http://ateam.lbl.gov/mv/.

ESPC

Energy Saving Performance Contract

Examples of Federal ESPC contract mechanisms include the Department of Energy's Super ESPC and UESC contracts. The Air Force and Army also have similar contract mechanisms.

ESCo

Energy Services Company

Commissioning

Commissioning is a process for achieving and verifying performance of building systems. Typically, commissioning is a part of any new or retrofit construction project. The purpose of commissioning is to ensure systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in compliance with the design intent. More information on commissioning is available at http://www.eere.energy.gov/femp/techassist/bldgcomgd.html.

Retro-Commissioning

Retro-Commissioning (Retro-Cx) is the commissioning of existing building systems to meet current building operating criteria. The retro-Cx process systematically reviews the condition of building systems and returns equipment that has fallen out of desired operating parameters back into appropriate tolerances. Retro-commissioning is the process of optimizing an existing building's operation and maintenance through the implementation of low-cost and no-cost improvements, and does not involve equipment replacement.

Retro-Cx focuses on energy using equipment such as mechanical systems, controls, and sometimes lighting. These systems are functionally tested and adjusted to meet the current needs of the building. In addition to adjusting for changing building criteria or operational goals, retro-Cx can also provide updated maintenance requirements for building systems. For additional information see "A Practical Guide for Commissioning Existing Buildings" by PECI and ORNL available through http://eber.ed.ornl.gov/commercialproducts/retrocx.htm.

Timing of Retro-Cx within the ESPC Process

Conducting retro-commissioning as part of a Federal ESPC process can be accomplished in a variety of ways, depending on the conditions present at the facility, the availability of funding, and the preferences of the Agency. The most likely scenario for incorporating retro-Cx into the FEMP Super ESPC process is outlined below. Comprehensive explanations of the steps for implementing retro-Cx in a Super ESPC are included in the *Example Retro-Commissioning Scope of Work*. Although the Super ESCP process is detailed, a similar procedure will apply to other Federal performance contracting mechanisms.

Initial Proposal (IP) Phase

The Agency should inform the ESCo of their interest in retro-commissioning at the initial project kick-off meeting prior to beginning the preliminary site survey for the Initial Proposal. The ESCo would then gauge the level of retro-commissioning opportunities at the site and report these in the Initial Proposal. The Agency should consider providing the *Example Retro-Commissioning Scope of Work* to the ESCo for modification and inclusion in the Initial Proposal.

Detailed Energy Survey (DES) Phase

The most effective way to determine retro-Cx opportunities is to identify opportunities in conjunction with building system measurements for baseline determination. Intent to proceed with the DES from the Agency should include clear instructions to the ESCO to include retro-Cx activities (see *Example Retro-Commissioning Scope of Work*). This will ensure audit costs associated with the identification of retro-Cx projects will be recoverable as a part of the project development costs, even if the energy conservation measure (ECM) is not implemented. After scoping, the cost savings and implementation costs for viable retro-Cx measures are included as an ECM.

ECM Implementation

Energy saving retro-Cx measures identified can be established as an ECM. The project baseline would be unaffected by the retro-Cx activities. Savings from the retro-Cx measures are attributed to the project, and implementation costs are included in the total contract cost.

Performance Period

Measurement and verification activities should include provisions to ensure the permanence of the savings during the performance period. Inclusion of ongoing retro-Cx services or periodic system check-ups as part of M&V activities will help ensure the persistence of the savings generated, and can be funded by the annual savings of the ECM bundle.

Measurement & Verification of Retro-Cx

Measurement and verification strategies for retro-Cx projects must be developed on a project-by-project basis. In general, the energy savings from retro-commissioning measures can be determined using typical M&V strategies, such as developing calibrated engineering models of the affected systems. Accounting for savings generated from retro-Cx will be dependent on the scope of the retro-Cx work, as well as the M&V strategies chosen for other ECMs.

In some cases, the modifications made during retro-Cx activities may be reversed over time by building occupants and maintenance staff. The persistence of the changes can be addressed through checking performance benchmarks, conducting periodic tune-ups, or a more aggressive "continuous commissioning" approach. Continuous commissioning is an ongoing effort to improve building performance by optimizing building systems though on-going tracking and adjustment of systems rather than a one-time fix. Typically, systems are benchmarked through measurements, and continuous monitoring is used to ensure the systems continue to operate as expected.

Pricing & Payment for Retro-Cx

The cost of retro-Cx is dependent on the scope of work and must be negotiated on a project-by-project basis. Including retro-Cx activities as part of the detailed energy survey (DES) will increase the cost of the survey. Developing a detailed scope of work and a fixed price for this work is important to eliminate risk to the Agency and the ESCo. Including a detailed scope of work in the Initial Proposal eliminates ambiguity in the retro-Cx work to be performed. Establishing a fixed price for the entire DES ensures that the incremental cost for these retro-Cx services will be covered as a part of the development costs for the overall project, whether or not viable measures are identified and ultimately implemented.

Other Key Issues

Other important items to consider, discuss, and agree upon when including retro-Cx with a Federal performance contract are outlined below.

- Determine the level of retro-commissioning services desired and identify the systems / equipment to be included in retro-Cx.
- Establish the level of involvement of facility staff and other contractors in initial retro-Cx scoping activities.
- Develop appropriate M&V strategies, including assessing the need for periodic tune-ups or a continuous commissioning approach.
- Ascertain the level of occupant and staff training needed.
- Assign on going service responsibilities.

Example Retro-Commissioning Scope of Work

To Include Services As Part of Super ESPC Detailed Energy Survey

Background

Agency requests that **ESCo** perform retro-commissioning services[1], as detailed herein, as a part of performing the Detailed Energy Survey (DES) for **site**. The incremental cost for these services will be covered as a part of the project development cost for the Super ESPC project, whether or not viable measures are identified and ultimately implemented.

It is the intent of the Agency to expand the work that will be performed during the DES. Leveraging the DES to complete a thorough scoping of retro-commissioning opportunities will substantially enhance the value of the ESCO services by ensuring that fundamental building systems are calibrated and operating as required to deliver functional and efficient performance. This work will also result in written system operation sequence for the included systems, which help train facility staff. Additional documentation of operating conditions prior to implementing retrofits will be valuable.

The cost effective measures identified it the Final Retro-Commissioning Report shall be included in the Final Proposal for a Super ESPC Delivery Order. The Agency agrees to credit the verified savings identified from these measures to the overall project, even if the measures are implemented by Agency staff prior to award of the Delivery Order (DO).

Objectives

The primary objectives for conducting these activities are:

- Enhance documentation of the operational and maintenance (O&M) requirements for the equipment and systems included
- Document baseline operating conditions through trending of performance measurements
- Optimize control systems through calibration of critical sensors, review metered data and trend logs, and functional equipment testing
- Identify operational and maintenance enhancements that result in improvements in energy efficiency, occupant comfort, or indoor air quality.
- Identify O&M staff training needs

[1] Background information on retro-commissioning is available in *A Practical Guide for Commissioning Existing Buildings* through http://eber.ed.ornl.gov/commercialproducts/retrocx.htm.

Systems To Be Included

(If it is not possible to include all major building systems and equipment, select the critical items for inclusion. Generally, the largest energy using equipment as well as systems known for having problematic controls, or operational and comfort problems should be included in the study. Refer to *Continuous Commissioning Guidebook*[2] for example measures and technical guidance.)

For all buildings included in the DES, the following systems should be included:

- Building automation system, including controlled devices, sensors, control loops, and logic
- Cooling systems
  - → Central cooling plant
  - → Primary air-handling units (AHUs)
  - → Terminal units
  - → DX systems
- Heating systems
  - → Central boiler plant
  - → Primary heating systems
- Fire safety / smoke purge aspects of the HVAC system
- Lighting systems
- Domestic hot water equipment
- Humidity control equipment
- Building pressurization controls

Project Steps

Overview of Project Steps

The following summarizes the project steps, which are detailed in the following sections.

1. Review existing systems and related documentation
2. Develop Retro-Commissioning Plan
3. Perform calibration and maintenance checks
4. Implement diagnostic monitoring / trending
5. Perform functional tests
6. Analyze the monitoring / trending and test data

---

[2] FEMP *Continuous Commissioning Guidebook for Federal Energy Mangers* by Texas A&M University, October 2002 is available through http://ateam.lbl.gov/mv.

7. Asses and document the current operating strategies and sequences of operation for all systems and equipment included
8. Document O&M improvement opportunities
9. Calculate energy impacts and develop implementation cost estimates for O&M opportunities
10. Develop and deliver the Final Retro-Commissioning Report
11. Include cost-effective measures in final proposal with other opportunities identified during the DES.

Detailed Project Steps

The following sections detail each of the project steps.

Review Existing Systems & Documentation

- Attending meetings through out the process including a retro-commissioning kick-off meeting in preparation for the site investigation.
- Interview Agency support staff and review the existing building documentation to determine the original specifications, design intent, and their relevance to current owner / user requirements. The following lists the documentation that needs to be gathered and reviewed:
  - → Sub-metered utility data and energy bill (electric and gas) information for at least 12 months along with rate schedules
  - → Drawings and specifications relevant to the systems scheduled for commissioning, especially control drawings and sequences of operation
  - → Existing control points list for each building
  - → Operating strategies programmed into the Energy Management and Controls System (EMCS)
  - → Equipment list with nameplate information for equipment controlled by the EMCS
  - → Existing O&M and system manuals for equipment
  - → Test and balance (TAB) reports; sensor calibration documentation

Develop Retro-Commissioning Plan

Develop a Retro-Commissioning Plan for testing and reporting on the pertinent systems, including documentation strategies. The Retro-Commissioning Plan should include the following:

- Equipment , systems, or specific measures to be included, or selection criteria for inclusion
- Plan for reviewing existing systems and related documentation
- Define current operational requirements from original design documents and interviews with Agency staff

- Detailed plan for equipment calibrations, including calibration forms
- Maintenance checks to be performed
- Detailed plan for diagnostic monitoring / trending, including data archival
- Functional tests to be performed
- Methods to be used in analyzing the monitored / trended data
- Plan to asses and document the current operating strategies and sequences of operation for all systems and equipment included
- Strategies to be used in calculating energy impacts and implementation cost estimates for opportunities identified
- Implementation schedule
- Define the content the Final Retro-Commissioning Report

Perform Calibration and Maintenance Checks

A list of sensors and actuators for calibration will be developed following a points list review. Using the trending capability of the control system for troubleshooting, testing and data gathering is a cost effective approach but only if the commissioning provider and building staff is confident that the sensors are reading properly. The appropriate amount of calibration work will depend on the level of confidence in the existing equipment and the history of problems with the controls equipment at an individual site. The calibration plan may include a compressive list of sensors and actuators, or critical components for select systems can be chosen. Example of critical control sensors include static pressure, outside air temperature, return air temperatures, mixed air temperature, discharge temperature, variable frequency drive (VFD) speed, flow meters, damper actuators, valve actuators, humidity sensors, and space temperature sensors.

Appropriate calibration procedures and required documentation should be included in the Retro-Commissioning Plan, including the following items:

- Test equipment used for calibration should have traceable calibration documentation provided in the final report.
- Document test equipment readings versus the EMCS sensor readings prior to adjustment.
- Document the adjustments made to match the EMCS sensor readings to the test equipment readings.
- A minimum of two points of calibration to check both slope and intercept is required for sensors seeing a wide range of conditions such as the outside air temperature sensors. Adjusting the off set may be sufficient for sensors seeing a narrow range of conditions.
- Document test equipment readings versus the EMCS sensor readings following adjustment (calibration) and note date and time of the adjustments made.

Two options for providing the needed labor and staffing to accomplishing the calibration procedures are outlined below, and summarized in Table 1. Both of the options require participation by Agency operating staff.

Option A: Commissioning Provider (ESCO) & Agency Staff Conduct Calibrations

Using forms and procedures developed by the Commissioning Provider (ESCO), the ESCO and Agency operating staff will investigate, document, and remedy any maintenance issues and perform calibrations as specified in the Commissioning Plan.

Successful completion of the calibrations is required prior to starting any monitoring, trending, and functional testing. This option is the least cost, but its viability depends on the level of expertise of Agency staff as well as their availability. This option is recommended. It provides the highest assurance of quality control and will help educate agency staff.

Option B: Controls Contractor and Agency Staff Conduct Calibrations

Using forms and procedures developed by the Commissioning Provider, the Controls Contractor and Agency staff would accomplish the calibration tasks specified in the Commissioning Plan.

The Agency would cover the cost of the Controls Contractor. This option may appear the most expensive (by hourly rate), but may actually take less time due to the Controls Contractor experience.

Table 1: Options to Accomplish Calibration of Critical Sensors

Option	Responsible Parties	Task Description	Cost Implication
A	Commissioning Provider (ESCO) assisted by Agency staff	Using forms and procedures developed ESCO, in-house support staff would work with Commissioning Provider (ESCO) to accomplish the calibration taskswould be participating with staff	Least cost depending on level of knowledge of staff and ability to make computer adjustments. Provides high level of quality control along with education for Agency staff
B	Controls Contractor assisted by Agency staff	Using forms and procedures developed Commissioning Provider (ESCO), the Controls Contractor, and Agency staff would accomplish the tasks	Most expensive by hourly rate but may be off set by taking less time due to Controls Contractor experience

Implement Monitoring and Testing

The commissioning provider provides a detailed request for required trend logs from the EMCS to the Agency staff or to the Controls Vendor, who executes the trends and provides the data to the commissioning provider (ESCO) in the specified electronic format.

If data loggers are required, the commissioning provider (ESCO) will provide and program the data loggers, which will be installed with the assistance of the facility staff. Facility staff may actually install current transformers and watt transducers on wiring

inside electrical cabinets. Facility staff may also be responsible for removing the sensors and data loggers, packaging them and sending them back to the provider for analysis after the end of the monitoring period.

Functional Testing

The commissioning provider (ESCO) oversees and conducts functional tests on selected equipment as specified in the Commissioning Plan, with the assistance of facility staff and Controls Vendor as required. Functional tests will be comprised of changing parameters, set-points or conditions and observing and documenting the actual system or equipment response through various modes and conditions (both simulated and real). Tests should be developed on a case-by-case basis to ensure functionality across normal operating conditions.

For equipment that is being monitored with sufficient points, manual testing may be accomplished by changing the parameters, etc. during the monitored period. The monitored data is then examined and used to document and verify correct or incorrect operation. Visual verification of equipment functionality may be required in instances that feedback from the control system is not available.

Analyze Monitoring and Testing Data

Once the data is gathered from monitoring and testing, the commissioning provider analyzes the findings by comparing actual equipment operation to appropriate operation and to the existing control sequences. Issues and potential improvements are identified and documented. Energy calculations are performed for those operational measures that appear to have the most impact to comfort, energy, or indoor air quality. Implementation costs for the measures will be estimated, and results will be presented in the Final Commissioning Report.

Assess and Document Current Operating Strategies

Commissioning provider will work with the Agency staff to develop a comprehensive building operations plan for the equipment and systems included in this scope of work, based on the original building specifications and current operational needs of the site.

Document and Analyze O&M Improvements

The Commissioning provider will document improvement opportunities identified. For the most promising measures, energy impacts will be calculated and implementation cost estimates developed.

Develop Final Retro-Commissioning Report

The Final Retro-Commissioning Report shall be issued once commissioning scoping activities are completed. This will be a separate deliverable from DO proposal, documenting the actions specified herein.

A Final Retro-Commissioning Report shall include the following information:

- Executive summary
- Project background and scope of the commissioning project
- Overview of activities conducted
- Details of all potential improvements identified and other findings, including:

        - Documentation of equipment conditions
        - Identify any needed facility staff training
        - Missing critical documentation
    - The estimated implementation costs and the energy impacts for each improvement
    - Current system operation sequences for all equipment and systems included

In Appendix:

- The Retro-Commissioning Plan
- The EMCS / data logger trended data, analysis, and annotated results. Electronic copies of the data should be provided.
- Completed calibration worksheets
- Documentation of government witnessing, as required

Include Recommended Measures in Final DES Proposal

The Final Retro-Commissioning Report will be presented once all activities are completed, and will precede the presentation of the DES or Final Proposal. The cost effective measures identified it the Final Retro-Commissioning Report shall be included in the Final Proposal for a Super ESPC Delivery Order, including a detailed measurement and verification strategy for each one. Functional tests of all operational modifications should be included as part of the final acceptance procedures for each measure in the DO.

The Agency agrees to credit verified savings identified from these measures to the overall project, even if measures are implemented by Agency staff prior to award of the Delivery Order.

Roles & Responsibilities

The following is an overview of the responsibilities for the team members, including Agency Lead Representative, Agency Technical Support Staff, the Commissioning Provider, and the Controls Contractor.

Agency Lead Representative

1) Provides overall supervision of this project
2) Is the party referred to as the “owner”
3) Develops contractual agreements
4) Ensures the participation of Agency staff
5) Funds the participation of the controls contractor as needed
6) Attends meetings as necessary

Agency Technical Support Staff - Building Operator / Engineer

1) Attends meetings as necessary

2) Reviews and accepts commissioning plan developed by Commissioning Provider
3) Ensures the participation of building personnel and controls contractors as needed
4) Assists in gathering the building documentation as needed
5) Provides input into the investigation process through interviews
6) Provides government witnessing of activities
7) Assists with implementation of sensor calibration
8) Performs or assists with setting up data trends in the EMCS
9) Performs or assists with the installation and removal of diagnostic equipment such as data loggers, as needed
10) Assists with performing functional tests
11) Ensures maintenance items affecting the project are remedied, such as replacing failed sensors

Controls Contractor

1) Attends project Kick-Off meeting to coordinate work
2) Assists with gathering data and setting up trends as needed
3) Assists with performing functional tests
4) Assists the Commissioning Provider in identifying and understanding the control sequences and programming of the EMCS

Commissioning Provider (ESCO)

1) Is the technical lead for this project
2) Conducts the Kick-Off meeting
3) Develops the Retro-Commissioning Plan
4) Reviews required documentation such as energy bills, sequences of operation, drawings, specifications, etc.
5) Conducts the operations site investigation including interviews, observations and analysis
6) Oversees all monitoring diagnostic planning and execution
7) Oversees any manual functional testing planning and execution
8) Conducts the engineering analysis and energy calculations
9) Develops the Final Retro-Commissioning Report